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Rolling boot with large radius of curvature

Description

The invention relates to a rolling boot for sealing two rotational parts which rotate together, which can be articulated relative to one another and/or which are axially displaceable relative to one another, which rolling boot has a longitudinal and symmetry axis A, and which rolling boot comprises the following: a first collar with a smaller diameter for being secured on a first rotational part with a smaller diameter, a second collar with a larger diameter for being secured on a second rotational part with a larger diameter, and an annular wall whose diameter widens from the smaller first collar to the larger second collar. Depending on the application, such rolling boots consist of rubber elastomer or plastic elastomer or certain mixtures. Depending on the material, they are produced by injection moulding or blow moulding. While being in the process of being produced, prior art rolling boots each comprise a conical annular wall which extends from the smaller first collar to the larger second collar and which, after having been removed from the mould, are folded backwards from the larger collar in such a way that the second larger collar, axially, is positioned so as to be relatively close to the smaller first collar as well as radially outside the annular wall which, in consequence, is positioned so as to be par-

tially radially double-walled. There is thus obtained a half-torus-shaped formation which, in the longitudinal half-section, comprises a substantially C-shaped curvature apex which, axially, is furthest removed from the first collar and the second collar.

In drawing illustrations of rolling boots of this type it is assumed that the curvature in the mounted condition of the rolling boot is substantially uniform and of a maximum size, if the internal stresses in the material are minimised.

For the purpose of reducing the internal stresses of a rolling boot in the mounted condition, it is proposed in the applicant's DE 102 31 075 that the annular wall which is conical during the production process should initially be fully folded over from the inside to the outside and then, starting from this configuration, it should be folded back towards the smaller collar. In this case, too, it is assumed in the drawing that there is achieved a uniformly large maximum radius of curvature of the rolling boot.

In actual fact, the drawing of rolling boots produced in accordance with the initially mentioned method is idealised. In reality, disadvantageous irregular radii of curvature form at the annular wall in the mounted condition of the boot. In addition, the static boot configuration is largely irrelevant for the service life of the rolling boot because it applies to low speeds only. Under the influence of centrifugal forces which are typical of the load spectrum of such rolling boots and are predominant, prior art rolling boots are deformed in such a way that a relatively sharp kink is formed in the region of the second larger collar, which kink, more particularly with first and second rotational parts which rotate and are articulated relative to one another, leads to considerable

flexing in the annular wall, which limits the service life of the rolling boot.

It is therefore the object of the invention to propose a rolling boot of said type which, under the influence of centrifugal forces, exhibits a more advantageous forming behaviour and thus promises a longer service life.

A first solution consists in that the annular wall, in the condition of being produced, at the unclamped-in rolling boot, in the longitudinal half-section, extends in an S-shaped way with an inner curvature next to the smaller first collar and with an outer curvature next to the larger second collar. Even in the static, built-in condition, the rolling boot described here - as compared to rolling boots according to the state of the art - comprises a more favourable increased radius of curvature of the annular wall in the region of the curvature apex. Furthermore, said increased radius of curvature in the region of the curvature apex is maintained even under the influence of centrifugal forces, i.e. also when the rotational parts rotate, so that the service life of rolling boots in accordance with the invention can be prolonged considerably. The S-shaped extension of the annular wall as visible in the longitudinal half-section is substantially such that the annular wall, in the condition of being produced, at the unclamped-in rolling boot, adjoins the smaller first collar so as to extend approximately axis-parallel relative to the longitudinal axis A and/or that the annular wall, in the condition of being produced, at the unclamped-in rolling boot, adjoins the larger second collar so as to extend approximately axis-parallel to longitudinal axis A. Depending on the type of the subsequent load with reference to the mutual articulation of the rotational parts and, respectively, the mutual axial displacement of the rotational parts, said axial extension of the rolling

boot in the condition of being produced can be more or less straight, i.e. the length of the annular wall in the axial direction can be adapted to the respective application. With certain given load spectra, shortened annular wall lengths are possible as compared to prior art rolling boots.

A second solution consists in that the annular wall, in the condition of being produced, at the unclamped-in rolling boot, in the longitudinal half-section, extends in a C-shaped way, having an inner curvature between the smaller first collar and the larger second collar. In this case, too, the qualitative effects and advantages as compared to rolling boots in accordance with the state of the art are the same as in the case of the first solution. From the point of view of shaping and production, the simple overall shape is advantageous. With rolling boots of this type, too, the radius of curvature in the region of the curvature apex under the influence of centrifugal forces is greater than in prior art rolling boots.

According to an advantageous embodiment of the latter solution, it is proposed that the annular wall, in the condition of being produced, at the unclamped-in rolling boot adjoins the smaller first collar so as to extend approximately axis-parallel to the longitudinal axis A. Furthermore, according to preferred embodiment it is proposed that the annular wall, in the condition of being produced, at the unclamped-in rolling boot, in the longitudinal half-section, adjoins the larger second collar at an acute angle relative to the longitudinal axis A.

Because of the overall reduction in flexing, which is due to the larger radii of curvature, impermissible temperature increases in the boot wall are avoided, which has an advantageous effect on the service life of the boot and on the ser-

vice life of the grease filling enclosed in the boot.

According to an advantageous further embodiment it is proposed that the smaller first collar is inwardly thickened relative to the annular wall. It is thus possible to avoid contact between the annular wall and the rotational part with the smaller diameter when the rotational parts are articulated relative to one another. According to a further advantageous embodiment, the smaller first collar, on its outside, comprises an annular groove for receiving a tensioning strip. In this way it is possible to prevent the first collar from being longitudinally displaced on the first rotational part, and preferably, an annular groove is also provided on the outside of the first rotational part.

According to a further advantageous embodiment, the larger second collar is provided in the form of a rounded bead. This is particularly advantageous in a case of cooperation with an annular attaching cap, with the second collar being beaded into same. Such an attaching cap in the form of the second rotational part or as transition piece towards the second rotational part preferably comprises a cylindrical shape which starts from the second collar. Under the influence of centrifugal forces, the annular wall can partly rest against the inner wall of said attaching cap. This has been taken into account in the intended advantageous form of the radius of curvature of the annular wall subjected to the influence of centrifugal forces.

Furthermore, it is proposed that on the inside of the smaller first collar there is provided a ventilation channel which is composed of longitudinal grooves circumferentially offset relative to one another and of a circumferential groove connecting the latter. In addition, it is proposed that at the

smaller first collar, axially opposite the annular wall, there is arranged a thin-walled protective sleeve which, at is free end, comprises the shortest distance from the longitudinal axis A.

Preferred embodiments of the invention are illustrated in the drawings and will be described below.

Figure 1 shows a first embodiment of an inventive rolling boot in the condition of being produced

a) in a longitudinal section

b) in a perspective view.

Figure 2 is a longitudinal half-section of the rolling boot according to Figure 1

a) in the condition of being produced

b) in the folded-over mounted condition free from centrifugal forces

c) in the folded-over mounted condition under the influence of centrifugal forces.

Figure 3 shows a second embodiment of an inventive rolling boot in the condition of being produced

a) in a longitudinal section

b) in a perspective view.

Figure 4 is a longitudinal half-section through the rolling boot according to Figure 3

a) in the condition of being produced

b) in the folded-over mounted condition free from centrifugal forces

c) in the folded-over mounted condition under the influence of centrifugal forces.

The two illustrations of Figure 1 will be described jointly below. They show an inventive rolling boot 10 in the condition of being produced after having been removed from its mould. The rolling boot is annular-symmetric relative to a longitudinal axis A. The rolling boot is shown in its most low-stress, self-adjusting condition. The rolling boot is shown to comprise a first collar 11 with a smaller diameter and a second collar 12 with a larger diameter. The two are connected by an annular wall 13 whose diameter widens from the first collar to the second collar and which is produced so as to be integral with both collars. The first collar 11 is followed by a thin-walled protective sleeve 14 whose smallest diameter is provided at the free end of same. The first collar 11 is to be fixed on a first rotational part, more particularly a drive-shaft and comprises a substantially internally cylindrical seat face 15 and, on its outside, an annular groove 16 in which a tensioning strip can be fixed axially. A ventilation system inside the first collar 11 comprises two longitudinal grooves 17, 18 which are circumferentially offset relative to one another, as well as a circumferential groove 19 positioned between the longitudinal grooves 17, 18 and connected thereto. There is thus ensured a constant exchange of gas pressure between the interior of the rolling boot and the surroundings of the mounted rolling boot. The protective sleeve 14 prevents the direct penetration of dirt into the longitudinal groove 17.

The second collar 12 is shown to be substantially rounded and bead-shaped on its outside and is thus suitable for being beaded into an annular attaching cap. As will be explained below, the condition of production as illustrated here is not identical with the condition of the boot when in use. This will be explained in connection with Figure 2.

Figure 2 shows the rolling boot according to Figure 1 in a longitudinal half-section, with the longitudinal axis A also being shown, but circumferential edges have been eliminated to simplify the illustration. The purpose of illustration a) is to show that the annular wall 13 comprises a first portion 13_1 which, in the longitudinal half-section, adjoins the first collar 11 so as to extend approximately axis-parallel to the axis A and which comprises an inner curvature in the longitudinal half-section. There then follows a second portion 13_2 which, in the longitudinal half-section, adjoins the second collar 12 so as to extend approximately axis-parallel to the longitudinal axis A and which comprises an outer curvature in the longitudinal half-section. In the longitudinal half-section, said wall is thus substantially S-shaped with a curvature reversal point between the two portions 13_1 and 13_2.

In illustration b), the same rolling boot is shown for the first time in its mounted position in a stationary condition. It again shows the longitudinal axis A and in addition, a first journal-shaped rotational member 21 and an annular-cap-shaped second rotational member 22 of which only the contour facing the rolling boot is illustrated. A tensioning strip 23 which clamps the first collar 11 on to the shaft journal 21 is slipped on to the first collar 11. The free end of the protective sleeve 14 is positioned on the shaft journal 21. The first collar 11 is positioned in a circumferential groove 24 of the shaft journal 21. In the region of the annular wall 13, the rolling boot is folded over, so that, if viewed radially, it has been doubled, with the second collar 12 coming to rest axially relatively closely to the first collar 11 outside the first portion 13_1 of the annular wall. The rolling boot assumes a curvature in the longitudinal half-section, which curvature is largely constant in one direction, with the reversal point of the curvature, in the longitudinal half-section, if exist-

ing, having moved close to the second collar 12. In a three-dimensional sense, the rolling boot now has the shape of half a torus whose smallest radius of curvature in the longitudinal section is positioned in the region of the apex 20.

Illustration c) shows the rolling boot in the mounted condition under the influence of centrifugal forces. The second portion 13_2 largely contacts the inside of the second rotational member 22. The smallest radius of curvature continues to be positioned in the region of the apex 20 and has advantageously increased relative to the embodiment shown in illustration b). More particularly, it is now larger than that of rolling boots in accordance with the state of the art.

The two illustrations of Figure 3 will be described jointly below. They show an inventive rolling boot 10 in the condition of being produced after having been removed from its mould. The rolling boot is annular symmetric relative to a longitudinal axis A. The rolling boot is shown in its most low-stress, self-adjusting condition. The rolling boot is shown to comprise a first collar 11 with a smaller diameter and a second collar 12 with a larger diameter. The two are connected by an annular wall 13 whose diameter widens from the first collar to the second collar and which is produced so as to be integral with both collars. The first collar 11 is followed by a thin-walled protective sleeve 14 whose smallest diameter is provided at the free end of same. The first collar 11 is to be fixed on a first rotational part, more particularly a drive-shaft and comprises a substantially internally cylindrical seat face 15 and, on its outside, an annular groove 16 in which a tensioning strip can be fixed axially. A ventilation system inside the first collar 11 comprises two longitudinal grooves 17, 18 which are circumferentially offset relative to one another, as well as a circumferential groove 19 positioned

between the longitudinal grooves 17, 18 and connected thereto. There is thus ensured a constant exchange of gas pressure between the interior of the rolling boot and the surroundings of the mounted rolling boot. The protective sleeve 14 prevents the direct penetration of dirt into the longitudinal groove 17.

The second collar 12 is shown to be substantially rounded and bead-shaped on its outside and is thus suitable for being beaded into an annular attaching cap. As will be explained below, the condition of production as illustrated here is not identical with the condition of the boot when in use. This will be explained in connection with Figure 4.

Figure 4 shows the rolling boot according to Figure 3 in a longitudinal half-section, with the longitudinal axis A also being shown, but circumferential edges have been eliminated to simplify the illustration. The purpose of illustration a) is to show that the annular wall 13 in the longitudinal half-section adjoins the first collar 11 so as to extend approximately axis-parallel to the axis A and comprises an inner curvature in the longitudinal half-section. The annular wall 13, in the longitudinal half-section, adjoins the second collar 12 so as to extend at an acute angle relative to the longitudinal axis A. In the longitudinal half-section, the wall is thus substantially C-shaped.

In illustration b), the same rolling boot is shown for the first time in its mounted position in a stationary condition. It again shows the longitudinal axis A and in addition, a first journal-shaped rotational member 21 and an annular-cap-shaped second rotational member 22 of which only the contour facing the rolling boot is illustrated. A tensioning strip 23 which clamps the first collar 11 on to the shaft journal 21 is

slipped on to the first collar 11. The free end of the protective sleeve 14 is positioned on the shaft journal 21. The first collar 11 is positioned in a circumferential groove 24 of the shaft journal 21. In the region of the annular wall 13, the rolling boot is folded over, so that, if viewed radially, it has been doubled, with the second collar 12 coming to rest axially relatively closely to the first collar 11, with a second portion 13_2 being positioned outside the first portion 13_1 of the annular wall. In a three-dimensional sense, the rolling boot now has the shape of a deformed half-torus whose smallest radius of curvature in the longitudinal section is positioned in the region of the apex 20.

Illustration c) shows the rolling boot in the mounted condition under the influence of centrifugal forces. The second portion 13_2 partly contacts the plate metal cap 22. The smallest radius of curvature continues to be positioned in the region of the apex 20 and has advantageously increased relative to the embodiment shown in illustration b). More particularly, it is now greater than that of rolling boots in accordance with the state of the art.

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List of reference numbers

10	rolling boot
11	first collar
12	second collar
13	annular wall
14	sealing sleeve
15	seat face
16	annular groove
17	axial groove
18	axial groove
19	annular groove
20	apex
21	shaft journal
22	annular gap
23	tensioning strip
24	annular groove
A	longitudinal axis